The Deep Underground Science and Engineering Laboratory

Kevin T. Lesko
Senior Physicist

DNP

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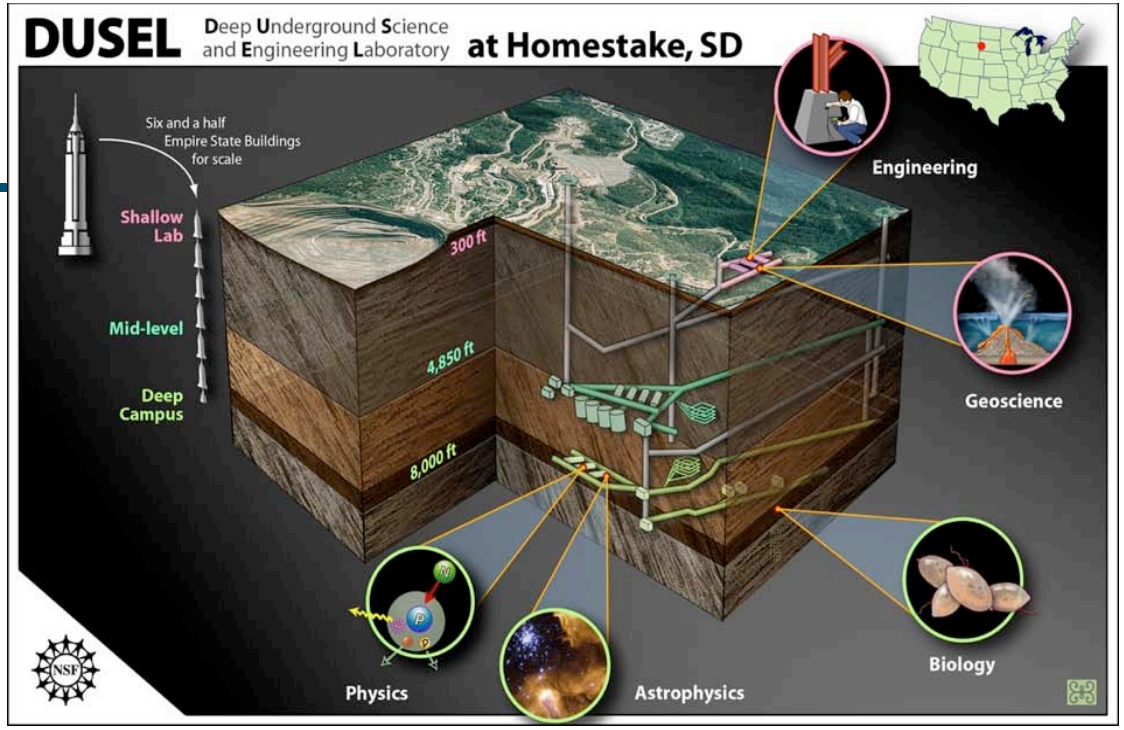
Outline



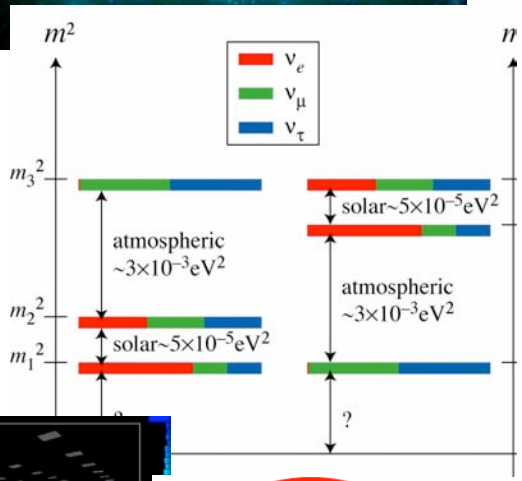
- Overview of DUSEL
- Underground Science Questions and Opportunities
- UC & LBNL Roles in the Science
- NSF Process for DUSEL
  - State and private involvement in Sanford Lab
  - DOE Participation in DUSEL
- LBNL and UC roles in DUSEL facility
- Schedule and Timelines
- Summary and Discussion

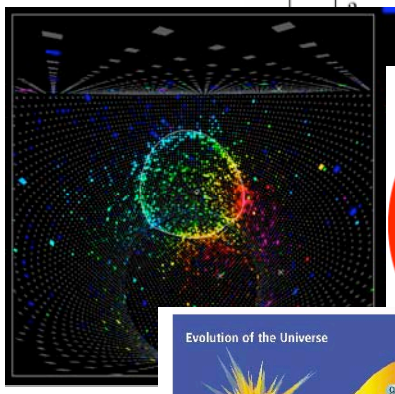
Overview of DUSEL

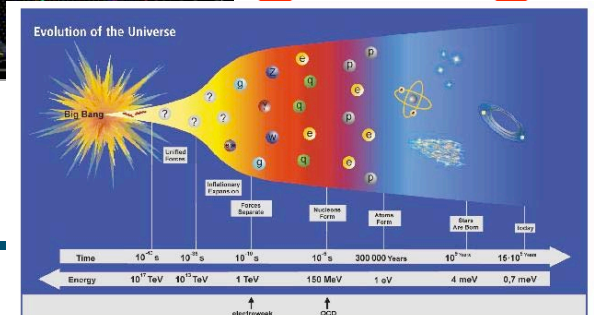
- The NSF's Deep Underground Science and Engineering Laboratory (DUSEL) is envisioned as a multidisciplinary underground facility. It will host efforts in:
  - Physics
  - Earth Science
  - Engineering
  - Biology
  - Education and Public Outreach
- DUSEL will host DOE and Other Agency's experiments and provide key infrastructure and support

Physics & Astrophysics

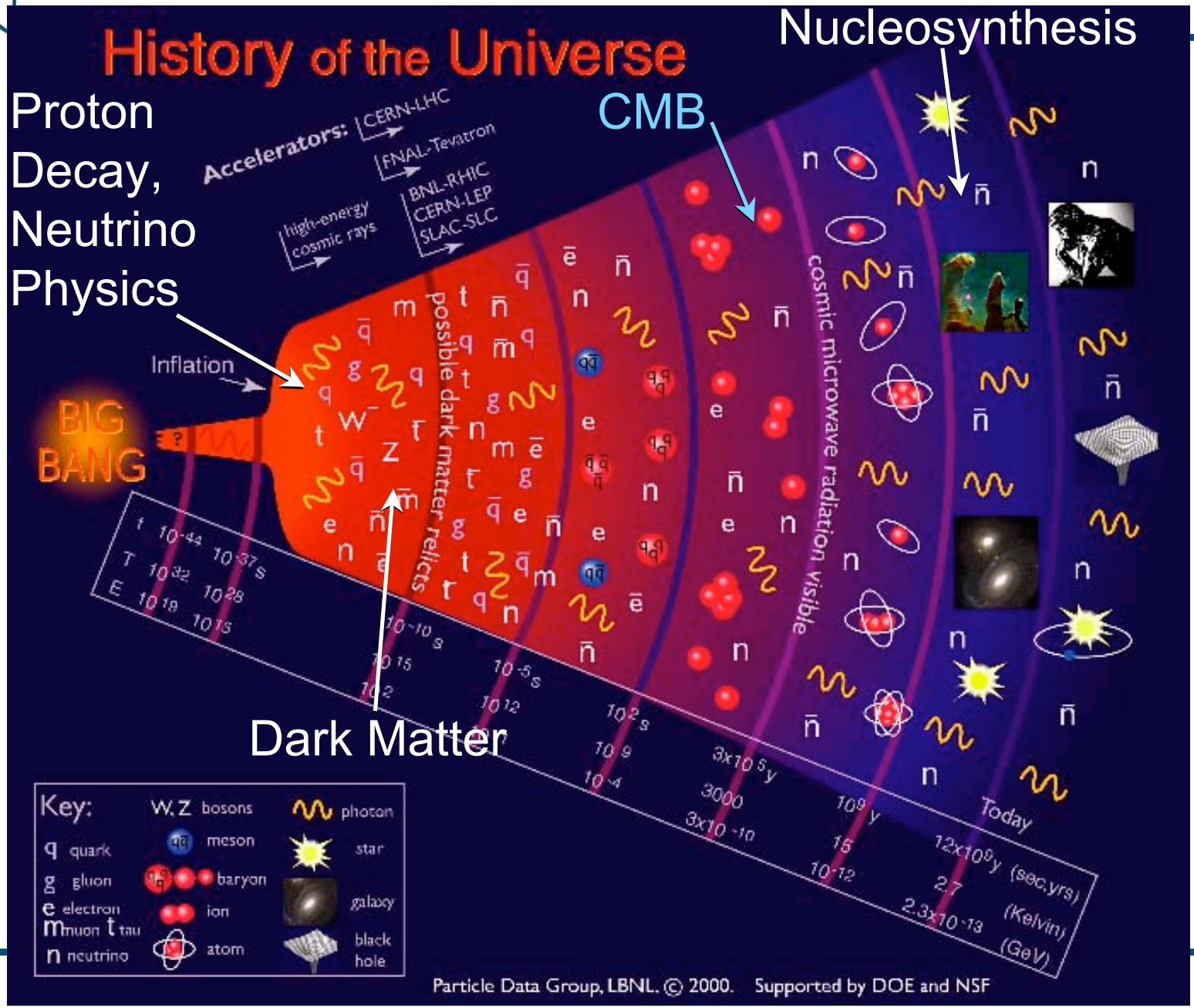
- What is the universe made of?
- What is dark matter?
- What are neutrinos telling us?
- What happened to the antimatter?
- Are protons unstable?
- How did the universe evolve?





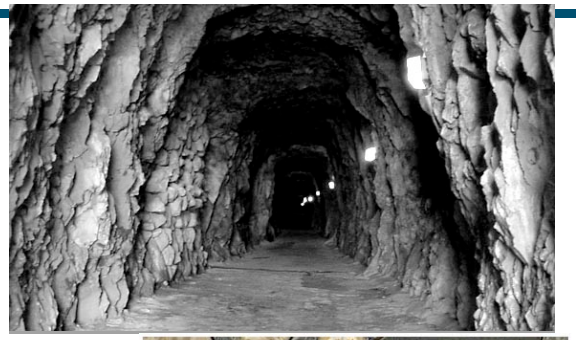


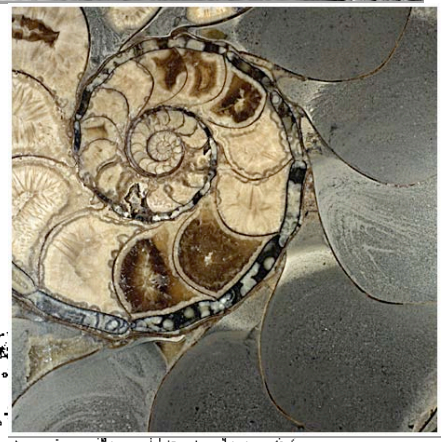
Studying the Early Universe

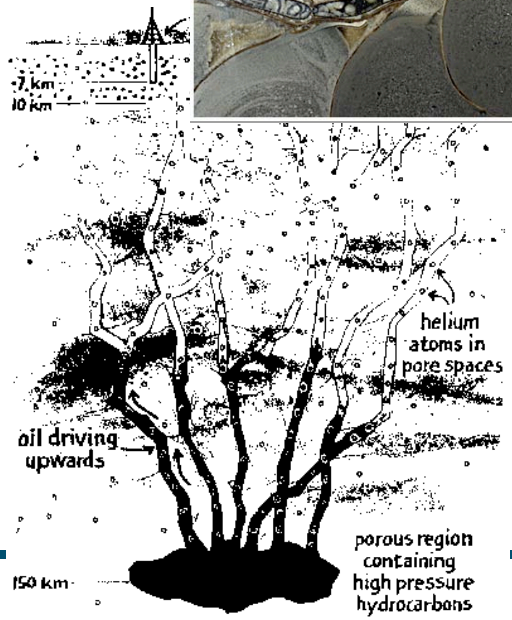


Geology & Biology

- How do biology and geology interact to shape the world underground?
- How does subsurface microbial life evolve in isolation?
- Did life on earth originate beneath the surface?
- Is there life underground as we don't know it?







Geology

- What are the interactions among subsurface processes?
- Are underground resources of drinking water safe and secure?
- Can we reliably predict and control earthquakes?
- Can we make the earth “transparent” and observe underground processes in action?

Geology & Engineering

- What are the mechanical properties of rock?
- What lies between the boreholes?
- How does rock respond to human activity?
- How does water flow deep underground?
- How can technology lead to a safer underground?

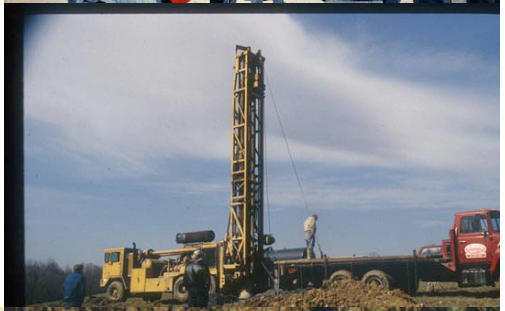
Scientific Rationale, Societal Imperatives, Grand Challenges

- Resource Recovery
  - Petroleum and Natural Gas Recovery
  - In Situ Mining
  - HDR/EGS
  - Potable Water Supply
  - Mining Hydrology
- Waste Containment/Disposal
  - Deep Waste Injection
  - Nuclear Waste Disposal
  - CO_2 Sequestration
  - Cryogenic Storage/Petroleum/Gas
- Site Restoration
  - Aquifer Remediation
- Underground Construction
  - Civil Infrastructure
  - Mining
  - Underground Space
  - Secure Structures

Both GeoHydrology and GeoMechanics

Mainly GeoHydrology

Mainly GeoMechanics



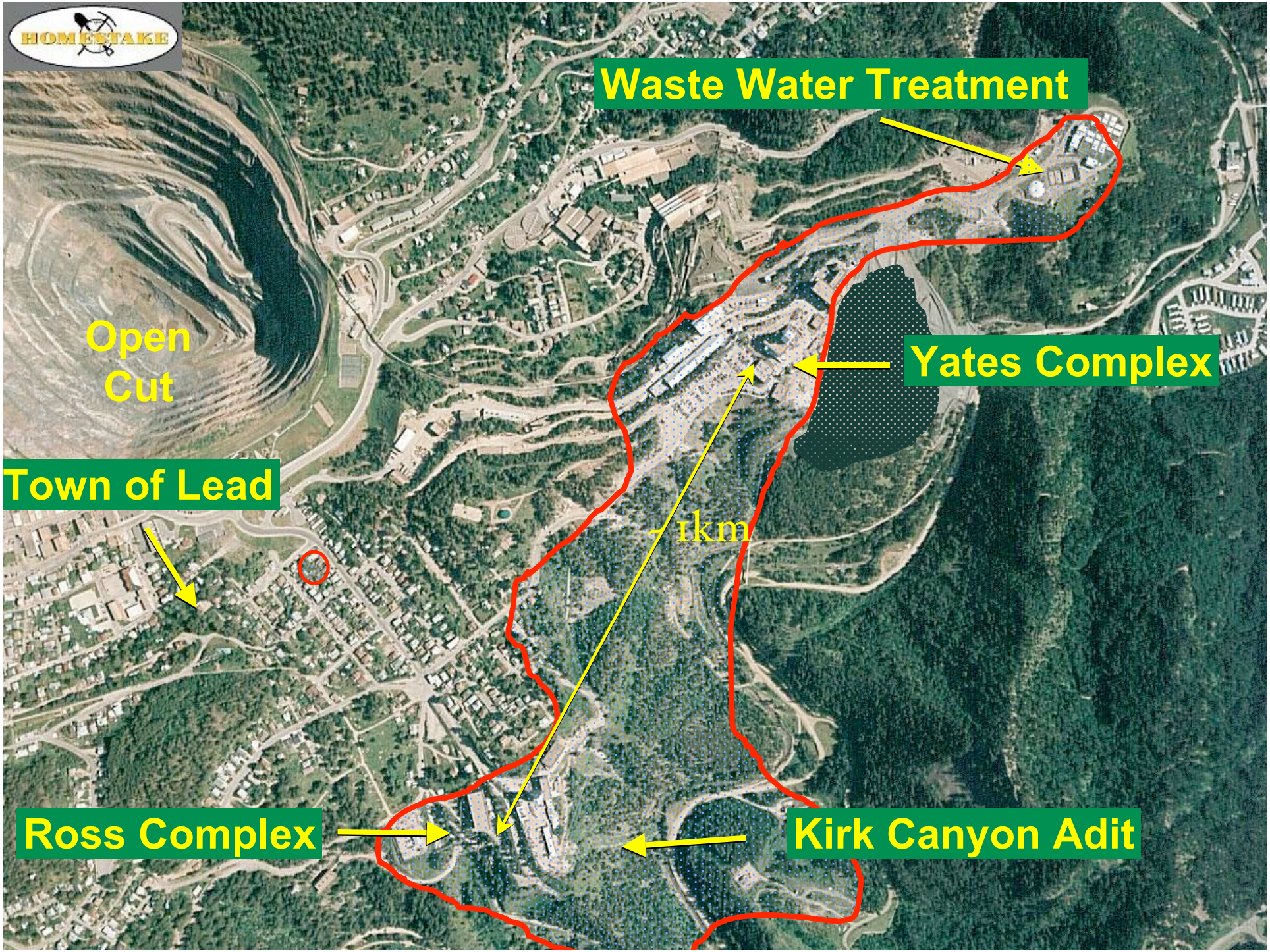
from DEDC, Elsworth

Education and Public Outreach

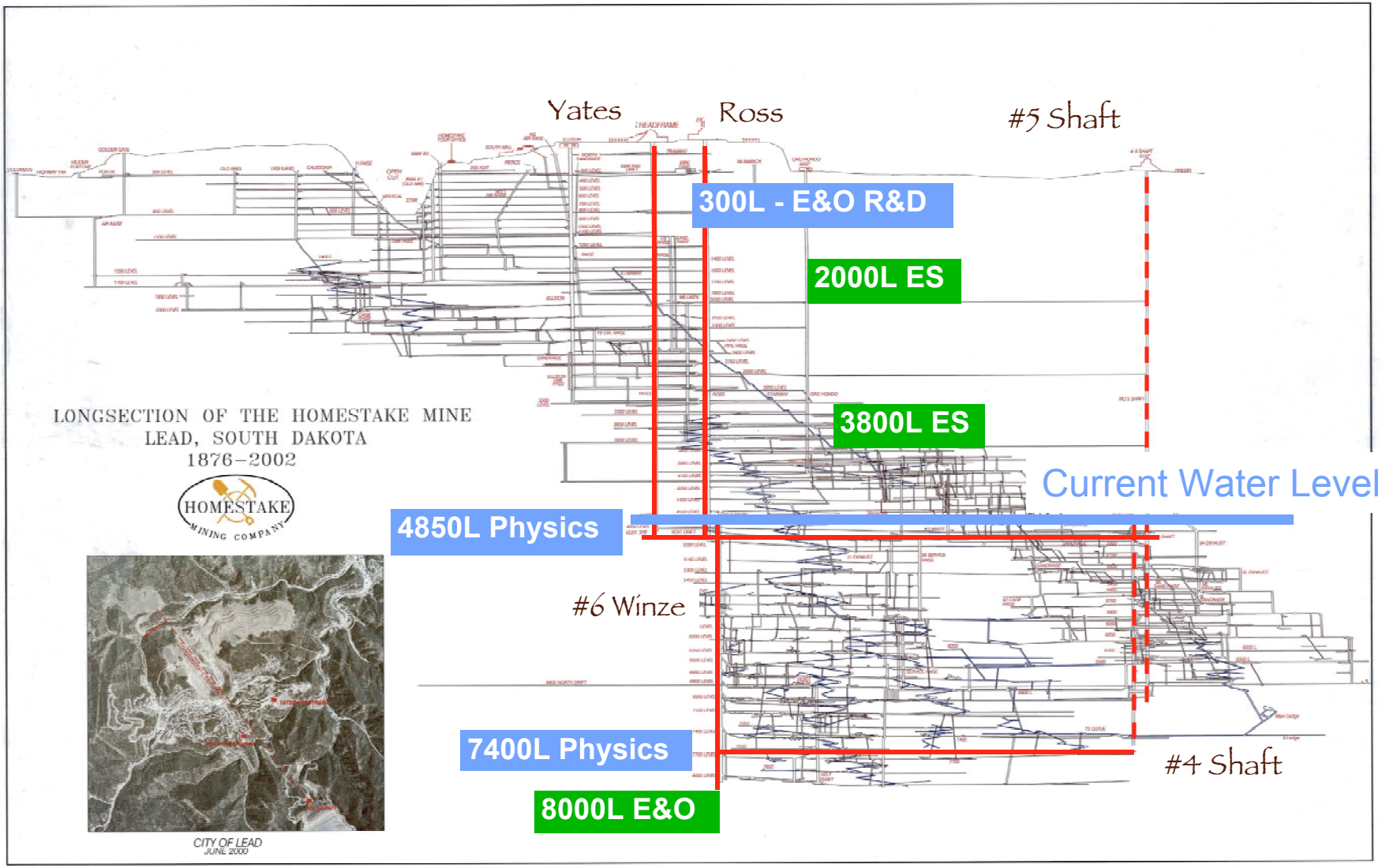
- Program rich with opportunities to integrate EPO throughout DUSEL
  - General Public & Casual Visitors
  - K-12
  - Teachers and Educators
  - Undergraduate Research Experience
  - Graduate Research
  - Cyber Infrastructure and Worldwide Reach
  - Multidisciplinary Opportunities
  - Successful Round Table in September 2008

South Dakota Efforts and Partnership

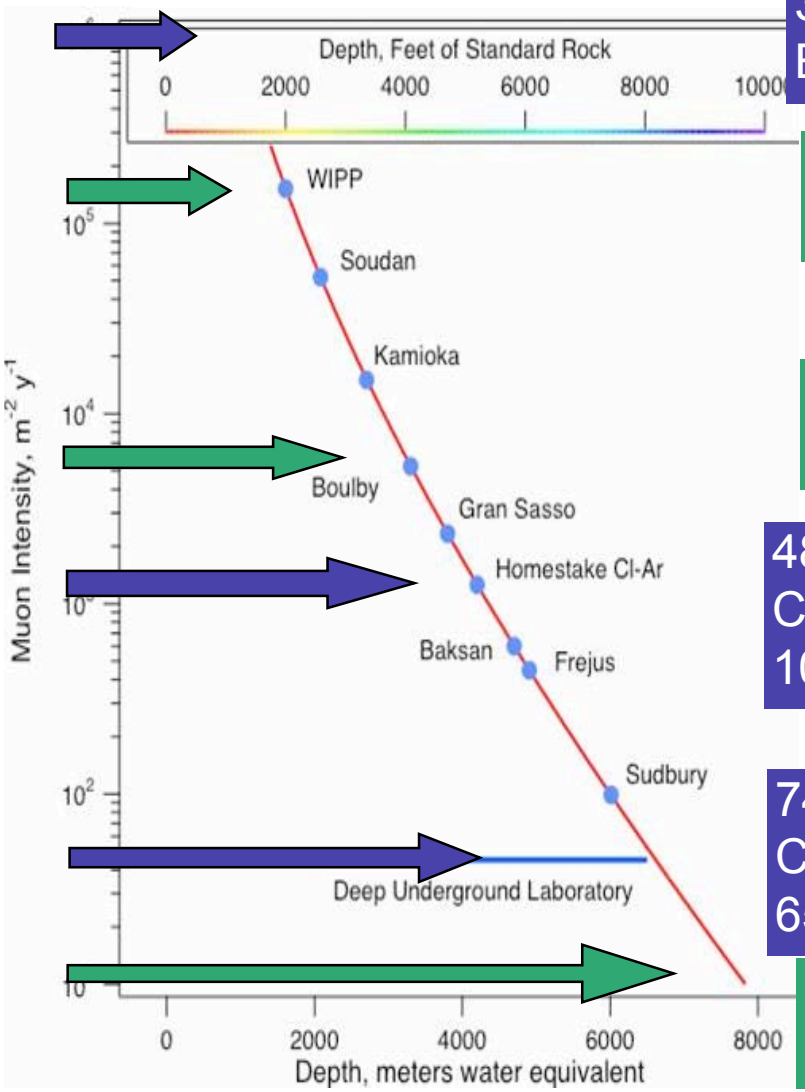
- Major Support from the State of South Dakota
  - $45M from State (HUD grant and General Fund)
  - $70M from Philanthropic Donation (T. Denny Sanford)
  - Owns the Property (Donation from Barrick)
- Partnership to “achieve DUSEL”
- Re-entry work:
  - Rehabilitation of Surface and U/G Infrastructure
    - Lifts & Shafts
    - Pumps
    - Facility Stabilization and Rehabilitation
    - Initial Science Program


HOMESTAKE
Waste Water Treatment
Open Cut
Yates Complex
Town of Lead
~1km
Ross Complex
Kirk Canyon Adit

Phased approach to DUSEL



Campus Footprint



300L R&D, E&O 10k ft^2

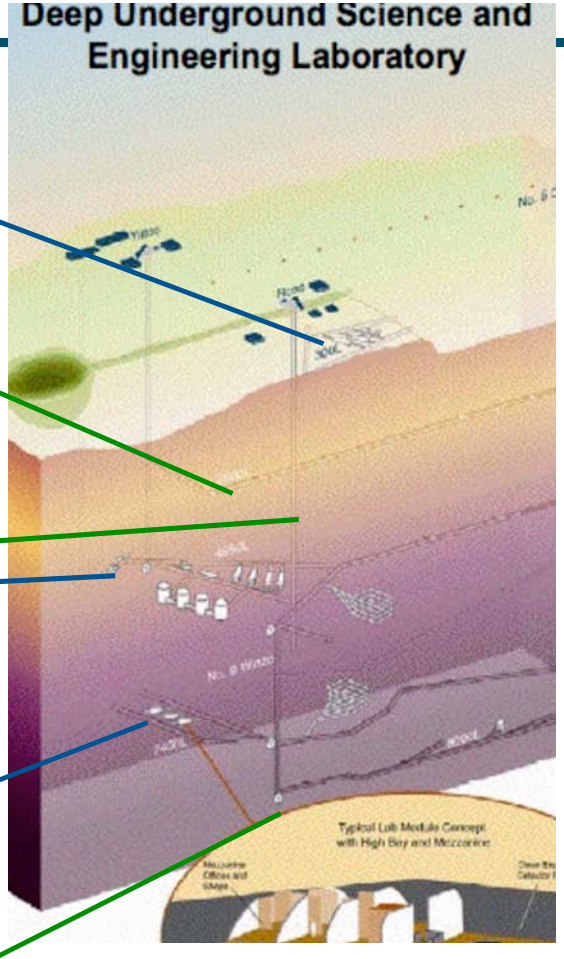
2000L Geo Level

3800L Geo Level

4850L Major Campus 100k ft^2

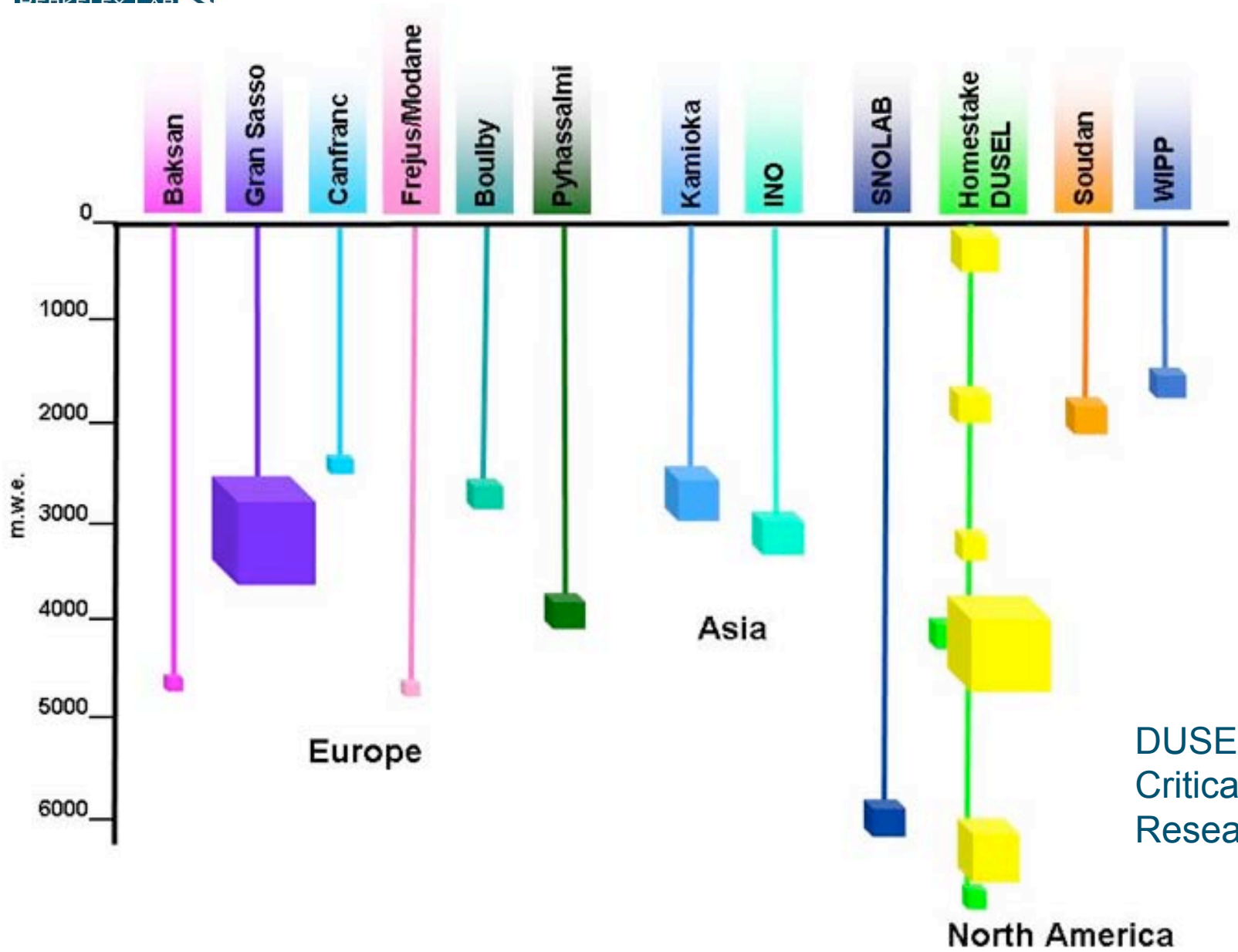
7400L Major Campus 65k ft^2

8000L Geo Lab

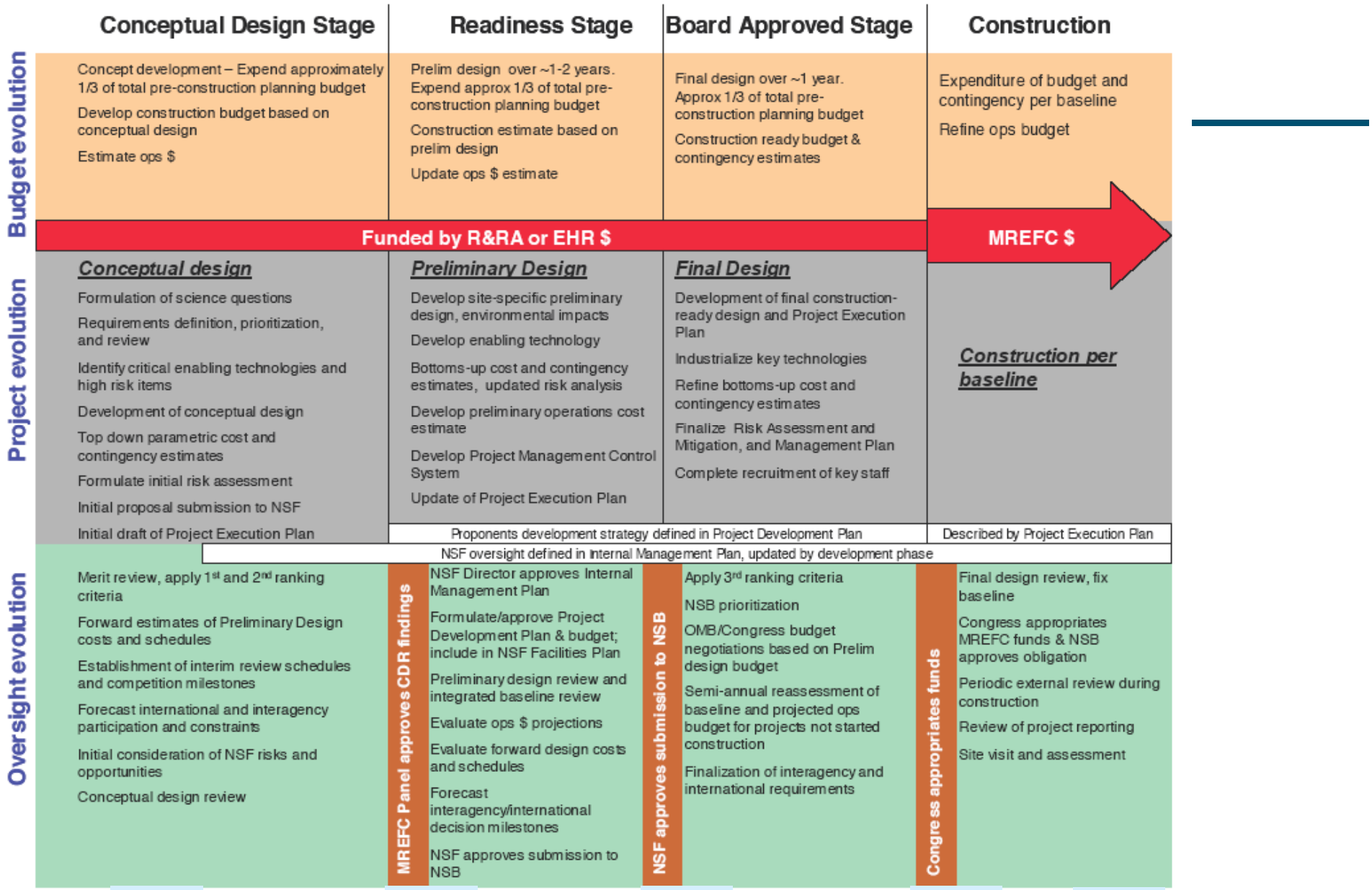


Details of the Conceptual Design at www.lbl.gov/nsd/homestake

Underground Laboratories



DUSEL Provides Critical U/G Research Space


Conceptual Design Stage
Readiness Stage
Board Approved Stage
Construction
Budget evolution
Concept development – Expend approximately 1/3 of total pre-construction planning budget
Develop construction budget based on conceptual design
Estimate ops $
Prelim design over ~1-2 years. Expend approx 1/3 of total pre-construction planning budget
Construction estimate based on prelim design
Update ops $ estimate
Final design over ~1 year. Approx 1/3 of total pre-construction planning budget
Construction ready budget & contingency estimates
Expenditure of budget and contingency per baseline
Refine ops budget
Funded by R&RA or EHR $
MREFC $
Project evolution
Conceptual design
Formulation of science questions
Requirements definition, prioritization, and review
Identify critical enabling technologies and high risk items
Development of conceptual design
Top down parametric cost and contingency estimates
Formulate initial risk assessment
Initial proposal submission to NSF
Initial draft of Project Execution Plan
Preliminary Design
Develop site-specific preliminary design, environmental impacts
Develop enabling technology
Bottoms-up cost and contingency estimates, updated risk analysis
Develop preliminary operations cost estimate
Develop Project Management Control System
Update of Project Execution Plan
Final Design
Development of final construction-ready design and Project Execution Plan
Industrialize key technologies
Refine bottoms-up cost and contingency estimates
Finalize Risk Assessment and Mitigation, and Management Plan
Complete recruitment of key staff
Construction per baseline
Proponents development strategy defined in Project Development Plan
Described by Project Execution Plan
NSF oversight defined in Internal Management Plan, updated by development phase
Oversight evolution
Merit review, apply 1st and 2nd ranking criteria
Forward estimates of Preliminary Design costs and schedules
Establishment of interim review schedules and competition milestones
Forecast international and interagency participation and constraints
Initial consideration of NSF risks and opportunities
Conceptual design review
MREFC Panel approves CDR findings
NSF Director approves Internal Management Plan
Formulate/approve Project Development Plan & budget; include in NSF Facilities Plan
Preliminary design review and integrated baseline review
Evaluate ops $ projections
Evaluate forward design costs and schedules
Forecast interagency/international decision milestones
NSF approves submission to NSB
NSF approves submission to NSB
Apply 3rd ranking criteria
NSB prioritization
OMB/Congress budget negotiations based on Prelim design budget
Semi-annual reassessment of baseline and projected ops budget for projects not started construction
Finalization of interagency and international requirements
Congress appropriates funds
Final design review, fix baseline
Congress appropriates MREFC funds & NSB approves obligation
Periodic external review during construction
Review of project reporting
Site visit and assessment
CD 0
CD 1
CD 2
CD 3
CD 4
Approve mission need
Approve alternate selection and cost range
Approve performance baseline
Approve construction start
Approve operations start

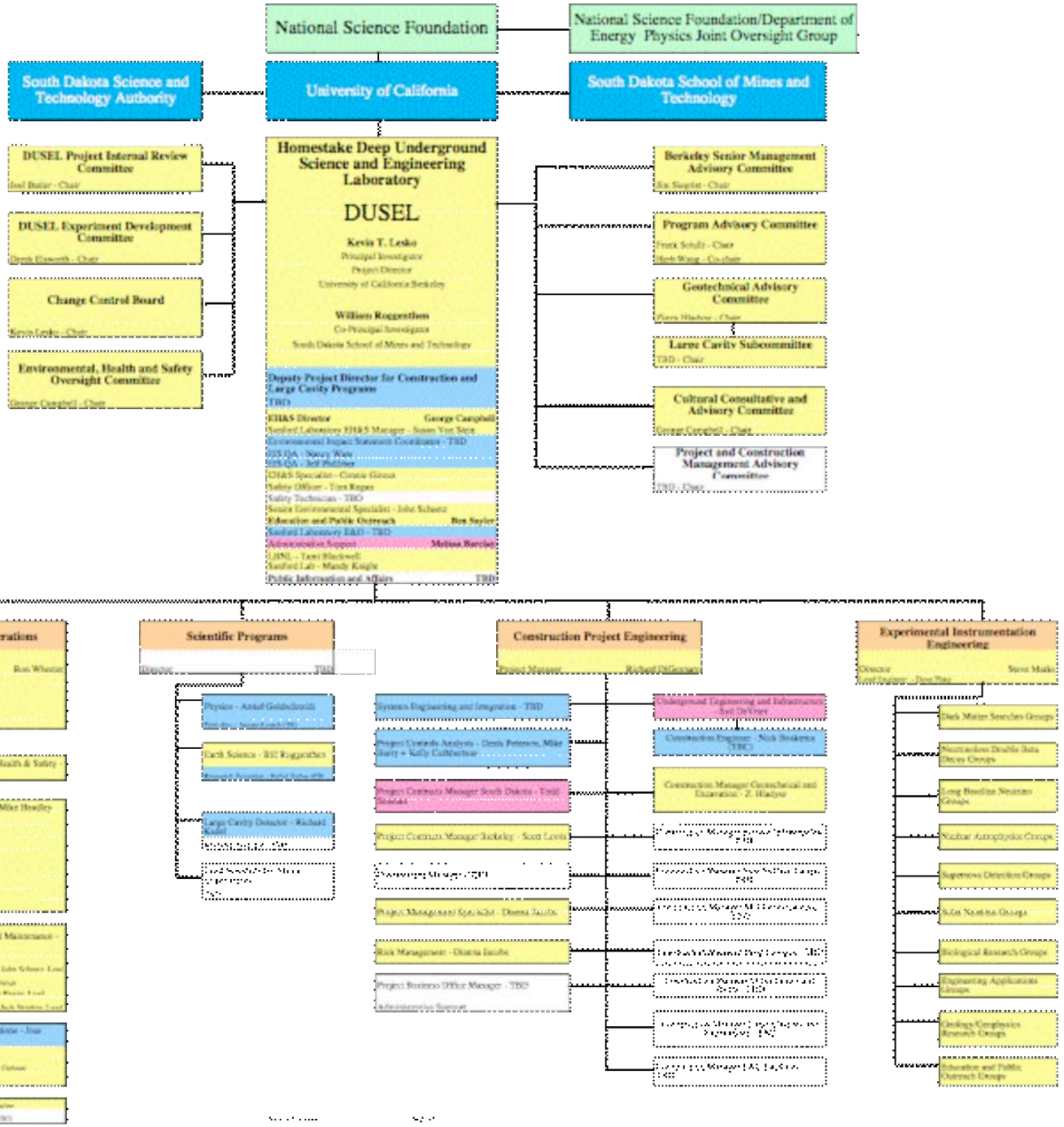
Near-term Goals: Preliminary Design

- **Site Selection 2007**
- **S-3 $15M funding over 2008 - 2010 (Facility Design)**
  - **Geotechnical Report 2009**
  - **Excavation Plan 2009**
  - **Infrastructure Report 2009**
  - **Laboratory Expt'l Requirements Report 2009**
  - **EH&S Integrated Safety Management Plan 2009**
- ***Preliminary* Facility Baseline Report FY09**
- **S-4 $15M funding over 2009 - 2011 (Experiments)**
- **Proposal Integrated with Experiments in FY10**
- **Review by National Science Board Spring 2011**
- **OMB Negotiations & Submission to Congress**
- **NSF Review and Earliest Funding in FY13**

	Major Activities, Contracts, and Project Milestones					
	FY08	FY09	FY10	FY11	FY12	FY13
Project Management & Systems Engineering	Project Office Staffing	Project Office Staffing	Project Office Staffing			
Geotechnical Studies & Excavation Design	Let: Geotechnical Contract	Geotechnical Report	**Excavation PDR**		**Excavation FDR**	
Surface and Underground Infrastructure	Let: Infrastructure Contract	Infrastructure Assessment Report	**Surface & Underground Infrastructure PDR**		**Surface & Underground Infrastructure FDR**	
Large Cavities Geotechnical Studies & Excavation Design		Geotechnical Investigations	Large Cavity Geotechnical Report	**Large Cavity PDR**		**Large Cavity FDR***
Laboratory Modules	Let: Laboratory Design Contract	Laboratory Requirements Document	**Laboratory Modules PDR**		**Laboratory Module FDR**	
Experimental Instrumentation Requirements	Assess Experiments and Accumulate Conceptual Requirements	General Requirements Documentation	DUSEL Experimental Instrumentation Requirements Definition		DUSEL Experimental Instrumentation Report	
			Large Cavity Experimental CDR	Large Cavity Experimental *Preliminary* Baseline	Large Cavity Experimental Baseline	
Experimental Instrumentation Design		Instrumentation Design S-4	Instrumentation Selection S-5	**Instrumentation PDRs**	**Instrumentation FDRs**	**Instrumentation FDRs****
		Major Engineering & Design Efforts Organized within collaborations and coordinated by DUSEL				
Environment Health & Safety	Develop EH&S Requirements	Risk Mitigation and Project Development Studies	**Integrated Safety Management & Hazard Mitigation PDR**		**Hazard Mitigation FDR**	
		Preliminary Facility Baseline Report	*Preliminary* Experimental Instrumentation Baseline Report			
			Facility Baseline Report	Facility and Instrumentation Baseline Report		
				DUSEL PDR December 2010		**DUSEL Facility and Instrumentation FDR Fall 2012***
				NSB Presentation Spring 2011		**Anticipated Construction Start: FY13**

• Because of phasing of design efforts Large Cavity Final Design work will continue into MREFC construction

** because of phasing of the instrumental design work, several instrumentation FDRs will be completed after the start of MREFC construction


National Science Foundation
National Science Foundation/Department of Energy Physics Joint Oversight Group
South Dakota Science and Technology Authority
University of California
South Dakota School of Mines and Technology
DUSEL Project Internal Review Committee
DUSEL Experiment Development Committee
Change Control Board
Environmental, Health and Safety Oversight Committee
Homestake Deep Underground Science and Engineering Laboratory
DUSEL
Kevin T. Lesko
Principal Investigator
Project Director
University of California Berkeley
William Roggenthen
Co-Principal Investigator
South Dakota School of Mines and Technology
Deputy Project Director for Construction and Large Cavity Programs
TBD
EH&S Director
George Campbell
Education and Public Outreach
Ben Suyler
Administration Support
Melissa Barclay
Public Information and Affairs
TBD
Berkeley Senior Management Advisory Committee
Program Advisory Committee
Geotechnical Advisory Committee
Large Cavity Subcommittee
Cultural Consultative and Advisory Committee
Project and Construction Management Advisory Committee
Sanford Laboratory Operations
Director
Ron Wheeler
Scientific Programs
Director
TBD
Construction Project Engineering
Project Manager
Richard DeGrassi
Experimental Instrumentation Engineering
Director
Steve Marks

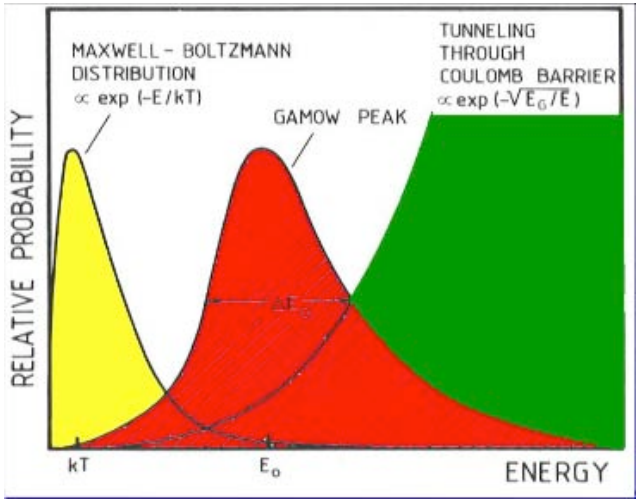
Other Agencies, Users, ...

The P5 report intimately links DUSEL to the future of the U.S. High Energy Community, including very significant participation by the Department of Energy laboratories and university groups including, importantly, the Fermi National Accelerator Laboratory. More critically, this report introduces the attractive prospect of significant new scope to DUSEL on an accelerated time scale. On this faster time scale the DUSEL facility is requested to support the excavation of large cavities exceeding the current state-of-the-art and the instrumentation of 100kt scale detectors, approximately five times the capacity of largest existing water Cherenkov detector, Super-K.

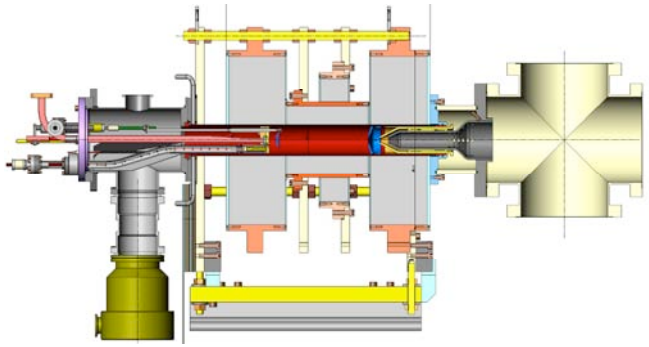
We conclude that the DUSEL Facility will be expected to support Mega- Cavity(ies) and Detector(s) Construction within the time frame of the MREFC (this is not a statement about funding)

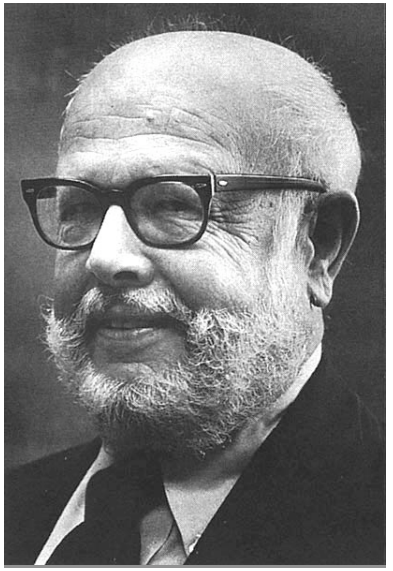
Physics Motivations: Nucleosynthesis

- A>60 formation in Supernovae, ν interactions
- Sources of neutrons for s-, r- processes
- Details of Lower Mass Nucleosynthesis
  - pp chain
  - CNO



$^{3}He(^{3}He,2p)^{4}He$
$^{3}He(\alpha,\gamma)^{7}Be$
$D(^{3}He,p)^{4}He$
$D(p,\gamma)^{3}He$
$^{7}Be(p,\gamma)^{8}B$
$^{14}N(p,\gamma)^{15}O$
$^{12}C(\alpha,\gamma)^{16}O$
...





DUSEL Attributes

- **DUSEL will be a Critical Facility with Unparalleled Attributes:**
  - Large, long term excavations to host a variety of experimental programs
  - Long term access to site (long term response of structures and active processes)
  - Access to unusual depth for important initiatives in deep science
  - Broad access to a large volume of rock (scale effects and transparent Earth)
- **A Facility for World-class Science and Engineering Science in:**
  - Physics
  - Biology
  - Geosciences
  - Engineering
- **Important Societal Impacts:**
  - Construction
  - Energy and sustainability
  - Resource recovery and sustainability
  - Education and Public Outreach
  - Natural Hazards…..

Summary

- World-class Research Programs
- Unique Capabilities
- Transformational Experiments
  - Physics
  - Earth Science
  - Biology
  - Engineering
- Efforts underway at Sanford Lab to prepare the site aligned with DUSEL efforts
  - phased program for experiments
- Long-term, Reduced Risk, Well-known Site
  - tailored access
  - 30+ year horizon, providing critical u/g space
  - no competition from other interests